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HILLTOPPING AS A MATING MECHANISM TO AID THE SURVIVAL OF LOW DENSITY SPECIES

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INTRODUCTION

Hilltopping insects have been reported to be rare by Catts (1964), Chapman (1954), Dodge & Seago (1954), and Hagen (1962), but no evidence has appeared for Lepidoptera. The purpose of this paper is to describe the difference in density of two groups of butterflies and skippers from Gregory Canyon, Boulder County, Colorado, those species which show hilltopping behavior and those without this behavior, and to give possible explanations why hilltopping species are rare. Mating mechanisms other than hilltopping are also discussed. General characteristics of hilltopping species are given.

HILLTOPPING DEFINED AND EXAMPLES OF HILLTOPPING

Hilltopping is defined as a behavior of certain insects in which males fly to the summits of hills and when there remain on the summit and show perching ("territorial") behavior or patrolling behavior, resulting in an unexpected abundance of males on hilltops. This is a behavioral definition; thus the distribution of males on hilltops is independent of the distribution of the foodplant. The foodplant may be only on the hilltop, or it may be a half mile away. Males may either perch on a shrub or spot of ground (for instance, *Papilio zelicaon*, Shields, 1968) or may "patrol" back and forth on the summit (Shepard, 1966, for *Pieris occidentalis*). Both types of behavior were noted by MacNeill (1964) in non-hilltopping situations for males of *Hesperia* ("occupation" behavior by *H. comma* and patrolling by *H. lindseyi*), so it is evident that hilltopping behavior is not fundamentally different from non-hilltopping behavior; hilltopping behavior occurs when these activities are transferred to a hilltop. Perching males may remain on a hilltop for several days; Shields (1968)

Table 1. Results of six hours of collecting on two hilltops within one mile of Gregory Canyon (the tops of Flagstaff and Green Mountains), showing the number of specimens caught and the difference between the abundance of these species on the two hilltops sampled and the abundance of the same species in Gregory Canyon. The hilltopping species increased an average of .91 specimens/hour on hilltops, while the non-hilltopping species decreased an average of 1.00 specimens/hour on the hilltops. (*data from Tables 2 & 3).

	male	fem.	Abundance on hilltops	Abundance in Gregory Can.*	Difference
A. Hilltopping species					
Erynnis persius	20		3.33	.61	2.72
E. pacuvius	4		.67	.14	.53
E. martialis	4	1	.83	.26	.57
E. afranius	3		.50	.80	- .30
Papilio zelicaon	14	1	2.50	.051	2.45
P. indra	2		.33	0	.33
P. rutulus	1	1	.33	.16	.17
P. eurymedon	5		.83	.63	.20
Pieris sisymbri	6		1.00	.17	.83
Oeneis chryxus	15		2.50	.24	2.26
Speyeria callippe	9		1.50	.18	1.32
S. edwardsii	4		.67	.12	.55
Vanessa atalanta	1		.17	0	.17
means			1.17	.26	.91
B. Non-hilltopping species					
Coenonympha tullia	1		.17	2.47	-2.30
Oeneis uhleri	2		.33	1.81	-1.48
Callophrys apama	2		.33	1.91	-1.58
C. polios	2		.33	1.26	- .93
Celastrina argiolus	7	9	2.67	1.40	1.27
means			.77	1.77	-1.00

recaptured marked *P. zelicaon* up to a month after release. Some species may visit hilltops only once, however, since of 46 *Vanessa cardui* males that Shields released on a summit, none were recaptured after more than a day. Hilltopping *Pieris occidentalis* do not stay long in any area (Shepard, 1966).

A "hilltopping species" is defined as a species which has been observed to show hilltopping behavior. Likewise, a non-hilltopping species is a species which does not show hilltopping behavior in the localities the author has studied. A rigid black-and-white separation of butterflies into hilltopping and non-hilltopping species is somewhat artificial; for some species of *Hesperia, Erynnis,* and *Papilio zelicaon,* hilltops probably serve as the primary site of mating, but for other species, such as *Speyeria* and *Ochlodes sylvanoides,* hilltops are probably minor. *Ochlodes sylvanoides* males perch on bushes in clearings both on hilltops and on flat areas. Nevertheless, this separation is presently justifiable until more is known about each species. *Papilio zelicaon* will serve as an example of a hilltopping species. In the spring of 1966 only one male and two females were caught in Gregory Canyon during almost sixty hours of collecting, but in one short trip to the top of Green Mountain (about one-half mile from Gregory Canyon) eight male *P. zelicaon* were caught in less than two hours. The males fly in rather fixed paths around the rock and through the trees on the summit; if missed, specimens usually return a few minutes later. Table 1 show the results of a brief period of collection on two hilltops near Gregory Canyon. The proportion of hilltopping species present, 13 out of a total of 18, was 72%, whereas it was 42% in Gregory Canyon where there are no hilltops. The densities of hilltopping species and nonhilltopping species were 1.17 and .77 respectively on the hilltops, while the densities for the same species in Gregory Canyon were .26 and 1.77.

GREGORY CANYON

During the spring of 1965, 1966, and 1967, the author made extensive collections of butterflies and skippers in Gregory Canyon, Boulder County, Colorado, a small foothills canyon on the eastern slope of the Front Range. It is less than a mile in length. The southern wall is covered with dense Douglas fir forest which is for the most part unsuitable for butterfly flight. The south-facing side of the canyon is a grassy slope with scattered ponderosa pines. In the bottom of the canyon is a variety of riparian shrubs and trees. Extensive collecting was done on the bottom and south-facing slope of the canyon, on the eastern slope of

Table 2. The abundance of nonhilltopping butterflies and skippers in Gregory Canyon.

Species	Dates of Captures	Specimens per hour
Ambylyscirtes vialus (Edwards)	4-v to 30-v	.20
A. aenus Edwards	16-v to 30-v	.15
A. oslari (Skinner)	13-v to 30-v	2.06
Euphyes vestris (Boisduval)	28-v	4.00XX
Poanes taxiles (Edwards)	30-v	.33XX
Polites themistocles (Latreille)	29-v to 30-v	1.40
P. mystic dacotah (Edwards)	29-v	.14XX
Oarisma garita (Reakirt)	24-v to 30-v	3.37
Pholisora catullus (Fabricius)	16-v to 24-v	.39
Pyrgus ruralis (Boisduval)	2-v to 13-v	.11
Epargyreus clarus (Cramer)	19-v to 30-v	.33
Papilio multicaudata Kirby	5-v to 29-v	.18
Colias alexandra Edwards	29-v	.14XX
C. philodice Godart	27-iii to 24-v	.38
Anthocaris sara julia Edwards	14-v to 30-v	.10
Coenonympha tullia ochracea Edwards	5-v to 30-v	2.47
Oeneis uhleri (Reakirt)	26-iv to 23-v	1.81
Euptoieta claudia (Cramer)	29-v	.14X
Phyciodes campestris camillus Edwards	13-v to 30-v	.62
P. tharos (Drury)	13-v to 30-v	.41
P. pallida (Edwards)	19-v to 29-v	.62
Nymphalis antiopa (Linnaeus)	13-iii to 27-iii	.76
Polygonia zephyrus (Edwards)	13-iii to 23-v	.67
P. satyrus (Edwards)	14-iv to 28-iv	.11
Limenitis wiedemeyeri Edwards	29-v	.14XX
Callophrys polios (Cook & Watson)	27-iii to 23-v	1.26
C. erephon (Boisduval)	30-iii to 24-v	1.12
C. fotis schryveri (Cross)	30-iii to 5-v	.40
C. apama homoperplexa Barnes & Benjamin	14-iv to 30-v	1.91
C. sheridanii (Edwards)	26-iii to 15-v	.81
Plebejus melissa (Edwards)	5-v to 30-v	.40
P. acmon lutzi dos Passos	13-v to 23-v	.071
P. icarioides lycea (Edwards)	14-v to 30-v	4.24
Glaucopsyche lygdamus oro Scudder	15-iv to 29-iv	2.74
Scolitantides piasus daunia (Edwards)	14-v to 30-v	1.36
Everes comyntas valeriae Clench	2-v to 30-v	.56
Philotes enoptes ancilla Barnes & McD.	5-v to 30-v	.68
Celastrina argiolus cinerea (Edwards)	14-iv to 30-v	1.40
		mean 1.034
XX-data thrown out because less than ten hours of collecting		s = 1.028